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EXAMINER

VOCKRODT, JEFF B

ART UNIT

PAPER NUMBER

2822

DATE MAILED: 04/04/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/553,997

Applicant(s)

BUCHANAN ET AL.

Examiner

Jeff Vockrodt

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 27 December 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-12,14-22 and 24-57 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-12,14-22 and 24-57 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

This office action is in response to the amendment filed on December 27, 2002. Claims 1-2, 4-12, 14-22, and 24-57 are pending. Claims 4-12 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made without traverse in Paper No. 10.

Specification

Page 24, line 13, "trimethyl or triethyl" is unclear, these are not compounds as far as the examiner is aware.

The Claimed Invention

In an effort to shed light on the examiner's interpretation of claim 1, and in view of the fact that the examiner considers claim 1 to no longer claim certain specific examples outlined in the specification, a statement of the claimed invention follows.

1. A precursor source mixture utilized for chemical vapor deposition or atomic layer deposition comprising at least one precursor compound which is dissolved, emulsified, or suspended in an inert liquid, where said precursor compound is bound to a ligand selected from the group consisting of hydride, carbonyl, imido, hydrazido, phosphido, nitrosyl, nitril¹, nitrate, nitrile, halide, azide, siloxy, silyl, with the proviso that the compound is not trimethyl amine alane. (Claim 1)

Claim 1 (the only independent claim) reads on the first mixture of example 3 (but not the second mixture of example 3) in this specification and the precursor mixtures of examples 2, 4, 5, 6, and 10 in this specification. Applicants are no longer claiming the subject matter in examples 1 and 7-9, and 11-12 of the specification. For instance, the first precursor mixture in example 1 includes a precursor compound tetrakis(dimethylamino) hafnium, $\text{Hf}(\text{N}(\text{CH}_3)_2)_4$, which has only amino ligands, the optional additive dimethylamine is an amine, and the inert liquid is pentane. Since claim 1 requires at least one ligand selected from a group that does not include

¹ Although both the group "nitril" and the group "nitrile" are recited, the examiner understands both to mean the same thing. (i.e., -CN).

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amine, and tetrakis(dimethylamino) hafnium has only amino groups, claim 1 does not read on this example. In contrast, example 2 includes dimethylamine alane, which has the formula Me_2NAIH_2 . Since dimethylamine alane has both hydride and amine groups attached to the aluminum atom, and hydride is among the ligands at least one of which is required by claim 1, claim 1 is interpreted to read on example 2 in the specification.

Claim Rejections - 35 USC § 112

The following are quotations from the first and second paragraphs of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-2, 14-22, and 24-57 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 requires "where said precursor compound is bound to a ligand selected from the group consisting of . . ." The specification gives numerous examples where a precursor metal atom is bound to a ligand, but none (as far as I can tell) show a precursor compound per se that is bound to a ligand of the type called for in the claim. In the case of dimethylamine alane, Me_2NAIH_2 , the hydride ligands apparently satisfy the ligand requirement, but to say that the precursor compound, which includes the hydride groups, is bound to a ligand, clearly departs from the literal terminology used in the claim. The scope of claim 1, and all claims that depend thereon is indefinite given this inconsistency between the specification and the claim terminology. To advance prosecution, the examiner will assume for purposes of this office action only that the claim is satisfied by a precursor compound including a precursor atom bonded to a ligand of the group called for in claim 1. Appropriate clarification by way of

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amendment is required to overcome this ground of rejection. Alternatively, if applicant traverses this ground of rejection without amendment, applicant is required to point out precisely where in the written description the subject matter of claim 1 resides. All claims that depend from claim 1 incorporate this defect by reference to claim 1.

Claim 57 depends from claim 1 and is "construed to incorporate by reference all the limitations of the claim to which it refers." 35 U.S.C. § 112 4th paragraph. Certain instances of the "precursor compound" that are listed in claim 57, however, fail to meet the criterion for the "precursor compound" set forth in claim 1, thereby creating unnecessary vagueness and uncertainty as to what is actually claimed in claim 57. For instance, claim 57 lists tetrakis(dimethylamino) titanium, which has a chemical formula of $(\text{Me}_2\text{N})_4\text{Ti}$. The only ligand coordinated, associated, or bound to this titanium precursor are amino groups (in particular, dimethylamine). Claim 1 does not include compounds with ligands that consist only of amino groups, since amino is not among the listed ligand groups. First, claim 57 lists: "trimethylamine, diethylmethylamine, dimethylethylamine, or triethylamine," without reference to a metal (or nonligand component), which alone renders these claim terms ambiguous. But even if a metal were appended to these ligand sets, they would fail to meet the criterion set forth in claim 1 if the metal to which they correspond do not have at least one of the specific ligands required by claim 1. Thus far, the only ligands in this group are alkyl and amino, neither of which are of the type called for in claim 1. Second, claim 57 calls for a number of compounds which do not meet the criterion of claim 1 including: tetrakis(dimethylamino), tetrakis(diethylamino) Ti, Zr, Hf, Si, Ge, Sn, or Pb; tris(dimethylamino) phosphine; tris(dimethylamino) antimony; tris(dimethylamino) arsine; tris(dimethylamino) stibine; bis(dimethylamino)(trimethylethylethylenediamino) aluminum; pentadimethylaminotantalum; hexadimethylaminoditungsten;

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trisdimethylamino(trimethylethylenediamino)titanium; $\{(\text{Me}_3\text{Si})_2\text{N}\}_3$ B, Al, Ga, or In; $\{(\text{Me}_3\text{Si})_2\text{N}\}_2$ Zn, Cd, or Hg.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-2 and 57 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Pat. No. 5,861,189 ("Sheel").

Sheel teaches pyrolytic deposition of aluminum using a dimethylethylamine alane precursor in a dimethylethylamine solvent (col. 6, ll. 52-65). Sheel therefore teaches a precursor compound having an amine ligand dissolved in an amine inert liquid.

Claims 1-2 and 57 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Pat. No. 5,783,716 ("Baum").

Baum teaches platinum source compositions for chemical vapor deposition of platinum. Baum teaches two precursor compounds having carbonyl ligands, $\text{Pt}(\text{CO})_2\text{Cl}_2$ and $(\text{C}_5\text{H}_5)\text{Pt}(\text{CH}_3)(\text{CO})$ (¶ bridging cols. 5-6), a precursor compound having a phosphido ligand, $\text{Pt}(\text{PF}_3)_4$ (col. 5, last ¶), and a precursor compound having a silyl ligand, the cyclopentadienyl trialkyl platinum compound with either trimethylsilyl or trimethylsilyl methyl R groups shown at

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col. 3, ll. 24-45. Baum teaches a number of inert solvents including hydrocarbons, ethers, alcohols, and esters to use with the precursor compounds (col. 6, ll. 23-32).

Claims 1-2, 14-22, and 24 are rejected under 35 U.S.C. §§ 102(a), 102(e) as being anticipated by U.S. Pat. No. 6,214,105 ("Hintermaier").

Hintermaier teaches alkane and polyamine solvent compositions for liquid delivery chemical vapor deposition. Hintermaier teaches two precursor compounds having phosphido ligands, $\text{MeAu(PMe}_3\text{)}$ and $(\text{Me}_3\text{P})\text{CuOtBu}$ (col. 3, ll. 50-60). The solvent is taught to consist of a mixture of A, B, and C. In a specific example, the mixture is 5:4:1 octane:decane:polyamide (col. 4, ll. 45-50).

Claim 14. Octane vaporizes at a higher temperature than these volatile precursor compounds. (the compound $(\text{Me}_3\text{P})\text{CuOtBu}$ of Hintermaier is identical to (tertbutoxy) CuPMe_3 disclosed in the specification, page 36).

Claim 15. Both octane and decane are C_{5-12} alkanes.

Claim 16. The ratio of additive to inert liquid is 1:9 which is less than 30%.

Claim 17. Component C can be a polyamine (col. 4, ll. 60-65).

Claims 18-22. The disclosure of trialkylamine is sufficient to anticipate trimethylamine since this is the simplest of trialkylamines. (see also rationale in office action mailed 4-10-02, page 6).

Claim 24. The term "optional" renders these components unnecessary to anticipate the claim.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to

a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 25-43 and 47 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hintermaier in view of U.S. Pat. No. 5,879,459 ("Gadgil").

Hintermaier teaches precursor and solvent compositions of chemical vapor deposition, including CVD of ferroelectric films. Hintermaier does not teach sequentially pulsing precursor, purge gas, and co-reactant into the CVD chamber.

Gadgil teaches a pulse pattern for depositing an AB type material from precursor gases Ax and By respectively. See Figs. 1a-1b. One cycle incorporates one pulse of Ax and one pulse of By, each precursor pulse separated by a pulse of purge gas. Col. 3, ll. 29-37. This sequence avoids reactions between the precursors. Col. 3, ll. 50-55.

It would have been obvious to one of ordinary skill in the art at the time of the invention to pulse the A and B components with intervening purge gas pulses in the deposition of the SBT layer of Hintermaier, because this configuration avoids reactions between the precursors as taught by Gadgil.

Claims 44-46 and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hintermaier and Gadgil as applied to claims 25-43 and 47 above, further in view of U.S. Pat. No. 5,382,817 ("Kashihara").

Hintermaier and Gadgil teach a process of forming a ferroelectric capacitor using a precursor and solvent in an atomic layer deposition apparatus, but fail to teach certain other materials of the ferroelectric capacitor.

Kashihara teaches a ferroelectric capacitor, Fig. 30, having a tungsten plug 352, TiN barrier 353a (see col. 16, 1st paragraph), platinum lower electrode 314, ferroelectric layer 315, and a platinum upper electrode 316.

It would have been obvious to one of ordinary skill in the art at the time of the invention to include a tungsten plug, TiN barrier, platinum lower electrode, and platinum upper electrode in the ferroelectric stacked capacitor of Hintermaier, because these materials were well known and desirable materials for forming ferroelectric stacked capacitors as taught by Kashiara.

Claims 49-52 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Hintermaier in view of U.S. Pat. No. 6,048,790 ("Iacoponi").

Hintermaier teaches a method of MOCVD using a copper compound but differs from claims 49-52 by not teaching specific application of the copper CVD to fabricate a wiring structure within trenches and vias in a dielectric layer (e.g. damascene interconnects); certain dielectric materials.

Iacoponi teaches MOCVD of copper films was well known and desirable for forming damascene interconnect that are formed within trenches and vias in an oxide layer (102, 110, 106) and a titanium barrier layer (112).

It would have been obvious to one of ordinary skill in the art at the time of the invention to use the copper precursor mixture taught by Hintermaier to form damascene metallization such as shown by Iacoponi. One of ordinary skill in the art would have been motivated to replace the precursors taught by Iacoponi for the precursor mixtures of Hintermaier for at least the reason that Hintermaier teaches using a solvent system that can be used for multiple species of precursor (col. 1, ll. 45-57).

Claims 53-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hintermaier and Gadgil as applied to claims 25, 26, 27, 39, 40, 41, 42, 43, and 47 above, further in view of U.S. Pat. No. 6067244 ("Ma")

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Hintermaier and Gadgil teach a process of forming a ferroelectric capacitor using a precursor and solvent in an atomic layer deposition apparatus, but fail to teach using the ferroelectric layer in a ferroelectric field effect transistor.

Ma teaches a ferroelectric field effect transistors, Figs. 1(a)-3(c), that comprise a gate, a source, a drain, a channel, and a ferroelectric material as the gate insulator.

It would have been obvious to one of ordinary skill in the art at the time of the invention to use the ferroelectric layer process taught by Hintermaier and Gadgil to form a ferroelectric FET, because ferroelectric field effect transistors were well known and desirable uses for ferroelectric materials as taught by Ma.

Response to Arguments

Applicant's arguments with respect to claims 1-2, 4-12, 14-22, and 24-57 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning communications from the examiner should be directed to Jeff Vockrodt at (703) 306-9144 who can be reached on weekdays from 9:30 am to 5:00 pm EST. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian, can be reached at (703) 308-4905.

The fax numbers for this Group are (703) 305-3432, (703) 308-7722, (703) 305-3431, and (703) 308-7724. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist at (703) 308-0956.

March 27, 2003

J. Vockrodt



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